CLAIMS

What is claimed is:

1. A power drive electronics apparatus operably connected between a frequency variable generator and an electric motor, comprising:

a three-phase diode rectifier having a three-phase AC input, a positive DC output terminal and a negative DC output terminal, said three-phase AC input operably connected to said electric motor and said positive DC output terminal operably connected to said frequency variable generator's rotor windings;

a diode having an anode and a cathode, said cathode operably connected to said positive DC output terminal of said three-phase diode rectifier;

a battery operably connected to said anode of said diode; and

a capacitor operably connected between said positive DC output terminal and said negative DC output terminal of said three-phase diode rectifier.

2. The power drive electronics apparatus according to claim 1 further comprising a switch having a first terminal and a second terminal, wherein said first terminal of said switch is operably connected to said battery and a second terminal of said switch is operably connected to said anode of said diode.

3. The power drive electronics apparatus according to claim 2 wherein said power electronics apparatus further comprises:

at least one high side switch having a first terminal operably connected to said positive DC output terminal of said three-phase diode rectifier, a second terminal operably connected to said frequency variable generator's rotor winding, and a control terminal; and

a controller operably connected to said control terminal of said at least one high side switch.

4. The power drive electronics apparatus according to claim 2 wherein said power electronics apparatus further comprises:

an inverter having a three-phase ac output, a positive DC input terminal and a negative DC input terminal, wherein said positive DC input terminal is operably connected to said positive DC output terminal of said three-phase diode rectifier, said negative DC input terminal is operably connected to said negative DC output terminal of said three-phase diode rectifier, and said three-phase ac output is operably connected to said frequency variable generator's rotor winding; and

a controller operably connected to said inverter.

5. The power drive electronics apparatus according to claim 4 wherein

said inverter includes three phase legs operably connected in parallel, each phase leg includes two switches operably connected in series; and

said controller includes a microprocessor, memory operably connected to said microprocessor, and software stored in said memory, said software includes instructions to turn said switches of said inverter on and off, whereby said inverter outputs a pulse width modulated electric current, said instructions include the following steps:

reading motor speed, generator speed and desired torque;

calculating a desired generator rotor current;

reading said desired generator rotor current, a DC bus voltage, and a three-phase generator rotor current;

calculating a desired instantaneous generator three-phase rotor current;

calculating a proportional and integration gain;

comparing said desired instantaneous three-phase generator rotor current with said three-phase generator rotor current;

producing a phase current error;

processing said phase current error;

calculating three-phase pulse width modulation duty cycles; and

outputting said three-phase pulse width modulation duty cycles.

6. The power drive electronics apparatus according to claim 4 further comprising an energy absorber operably connected between said positive DC output terminal and said negative DC output terminal of said three-phase diode rectifier.

7. The power drive electronics apparatus according to claim 4 wherein said frequency variable generator is a double-fed induction generator and said electric motor is an induction motor.

8. A multi-axle vehicle, having an engine, a first drive axle driven by said engine;

a drive assembly comprising

a frequency variable generator having an input shaft driven by said engine;

a stator with windings;

a rotor rotatable with said input shaft and relative to said stator, said rotor having a winding; and

a power drive electronics apparatus operably connected between said windings of said frequency variable generator and said electric motor;

an electric motor electrically connected to said frequency variable generator to receive output power from said generator; and

a second drive axle driven by said electric motor.

9. The multi-axle vehicle according to claim 8 wherein said power drive electronics apparatus includes:

a three-phase diode rectifier having a three-phase AC input, a positive DC output terminal and a negative DC output terminal, said three-phase AC input operably connected to said electric motor and said positive DC output terminal operably connected to said frequency variable generator's rotor windings;

a diode having an anode and a cathode, said cathode operably connected to said positive DC output terminal of said three-phase diode rectifier;

a battery operably connected to said anode of said diode; and

a capacitor operably connected between said positive DC output terminal and said negative DC output terminal of said three-phase diode rectifier.

10. The multi-axle vehicle according to claim 9 wherein said power drive electronics apparatus further includes a switch having a first terminal and a second terminal, wherein said first terminal of said switch is operably connected to said battery and a second terminal of said switch is operably connected to said anode of said diode.

11. The multi-axle vehicle according to claim 10 wherein said frequency variable generator is a double-fed induction generator and said electric motor is an induction motor.

12. The multi-axle vehicle according to claim 10 wherein said power drive electronics apparatus further includes:

at least one high side switch having a first terminal operably connected to said positive DC output terminal of said three-phase diode rectifier, a second terminal operably connected to said frequency variable generator's rotor winding, and a control terminal; and

a controller operably connected to said control terminal of said at least one high side switch.

13. The multi-axle vehicle according to claim 10 wherein said power drive electronics apparatus further comprises:

an inverter having a three-phase AC output, a positive DC input terminal and a negative DC input terminal, said positive DC input terminal operably connected to said positive DC output terminal of said three-phase diode rectifier, said negative DC input terminal operably connected to said negative DC output terminal of said three-phase diode rectifier, and said three-phase AC output operably connected to said frequency variable generator's rotor winding; and

a controller operably connected to said inverter.

14. The multi-axle vehicle according to claim 13 wherein said power drive electronics apparatus further includes an energy absorber operably connected between said positive DC output terminal and said negative DC output terminal of said three-phase diode rectifier.

15. The multi-axle vehicle according to claim 13 wherein said frequency variable generator is a double-fed induction generator and said electric motor is an induction motor.

16. A method of controlling magnitude and frequency of power delivered to a rotor winding of a generator, comprising:

applying system power to the rotor windings of the generator;

disconnecting said system power;

rectifying ac power from a motor;

pulse width modulating said rectified ac power; and

applying said pulse width modulated rectified ac power to the rotor winding of the generator.

17. The method according to claim 16 wherein further comprising the steps of:

pulse width modulating said rectified ac power; and

applying said pulse width modulated rectified ac power to the rotor winding of the generator.

18. The method according to claim 17 wherein said step of absorbing energy from said motor during deceleration.

19. The method according to claim 17 wherein said step of pulse width modulating said rectified ac power comprises:

reading motor speed, generator speed and desired torque;

calculating a desired generator rotor current;

reading said desired generator rotor current, a DC bus voltage, and a three-phase generator rotor current;

calculating a desired instantaneous generator three-phase rotor current;

calculating a proportional and integration gain;

comparing said desired instantaneous three-phase generator rotor current with said three-phase generator rotor current;

producing a phase current error;

processing said phase current error;

calculating three-phase pulse width modulation duty cycles; and

outputting said three-phase pulse width modulation duty cycles.

20. The method according to claim 19 wherein said step of absorbing energy from said motor during deceleration.